Cytoplasmic inheritance and its effects on development and performance.

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In contrast to nuclear inheritance, cytoplasmic inheritance in mammals is derived mostly, if not exclusively, from the maternal line. Mitochondria, and their DNA molecules (mtDNA), are the genetic units of this method of inheritance. Mammalian mtDNA codes for 13 enzymes used in the mitochondrial energy-generating pathway, oxidative phosphorylation, 22 tRNAs and two rRNAs. Although all transcripts of mtDNA and their translational products remain in the mitochondria, most proteins used in mitochondria are from nuclear DNA and are imported after synthesis on cytoplasmic ribosomes. Spermatozoa introduce a small number of mitochondria into the cytoplasm of the egg at fertilization, which appear to be digested soon after penetration. Although the paternal contribution of mtDNA to the offspring is not believed to occur in mammals, some interspecific crosses have suggested that it does occur. Experiments with animals derived from reconstituted embryos, using nuclear or cytoplasmic transplantations, suggest that nuclear-mitochondrial interactions are important but not essential in the survival and replication of exogenous mitochondria introduced into the egg. As the levels of heteroplasmy varied in several tissues of animals derived from reconstituted embryos, it is suggested that differential partitioning of mitochondria occurs during embryogenesis. Mitochondrial morphology changes substantially during oogenesis and throughout early cleavage stages. Somatic morphology and normal replication patterns are regained at the blastocyst stage. In pig oocytes and embryos, mitochondria aggregate and are closely associated with endoplasmic reticulum, lipid granules and large vesicles. Although the direct correlation of mitochondrial genes with reproductive traits is still unclear, some human degenerative diseases and performance traits in cattle can be related directly to specific mtDNA polymorphisms. In pigs, reciprocal-cross comparisons have indicated greater offspring parent similarity with dam than sire for lean:fat ratio. A difference was also observed for oxygen consumption and oxidative phosphorylation, but not

for anaerobic energy metabolism, in a pig reciprocal-cross experiment. Information on the transmission of mtDNA and its effects on performance will have many implications not only for our understanding of mitochondrial genetics but also for the increased productivity of animals. There are also potential ramifications to the animal cloning industry.

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